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REPORT OF PINE-BEETLE SURVEYS
on the
OCHOCO NATIONAL FOREST
SEASON OF 1939

Forest Insect Laboratory
445 U.S.Court House
Portland, Oregon

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REPORT OF PINE-BEETLE SURVEYS
on the
OCHOCO NATIONAL FOREST
SEASON OF 1939

Approved by:

F. P. Keen

F. P. Keen
Senior Entomologist, in Charge.

Submitted by:

W. J. Buckhorn

W. J. Buckhorn
Senior Scientific Aide.

Forest Insect Laboratory
445 U. S. Courthouse
Portland, Oregon
March 1940

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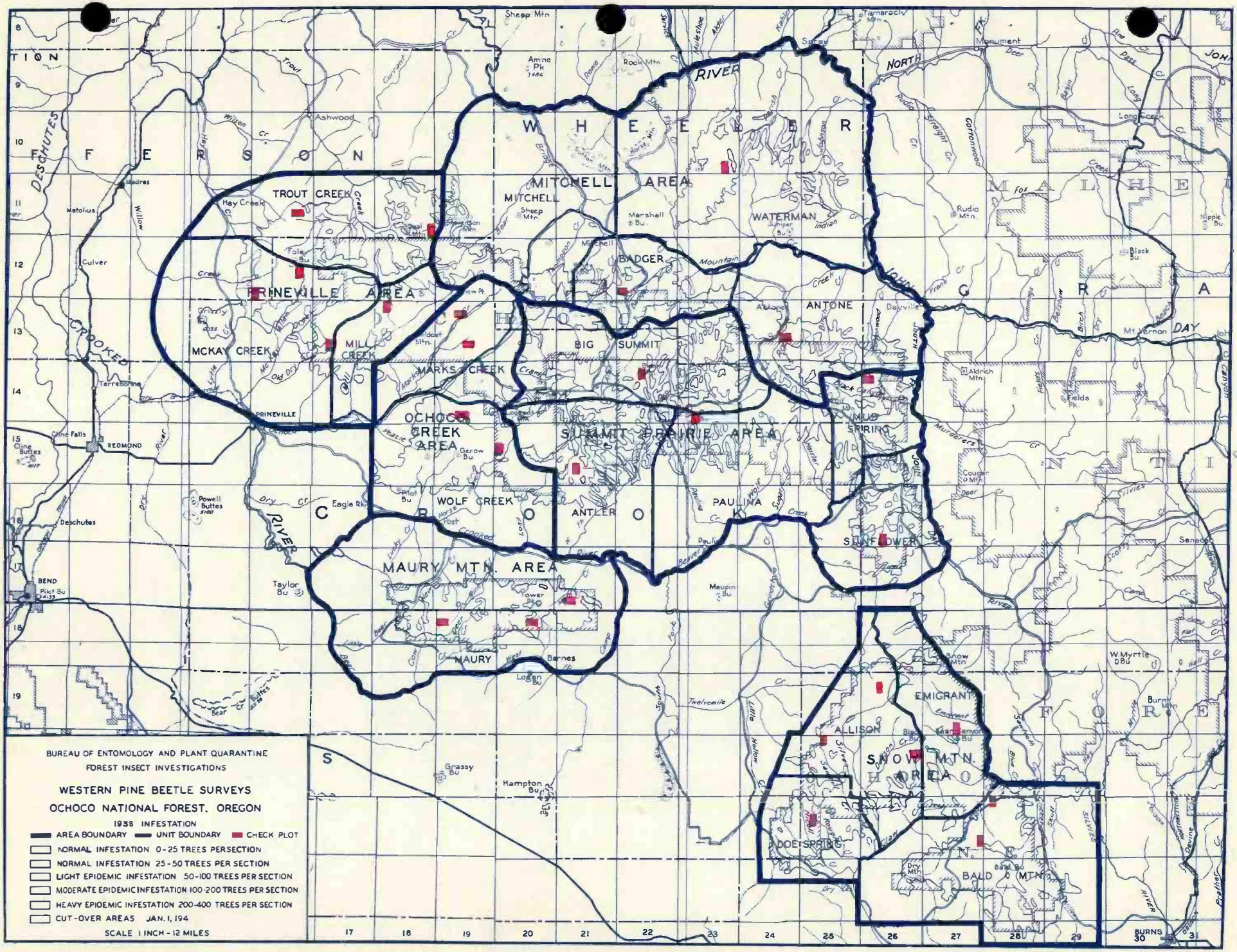
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
FOREST INSECT INVESTIGATIONS
WESTERN PINE BEETLE SURVEYS
OCHOCO NATIONAL FOREST, OREGON
1938 INFESTATION
AREA BOUNDARY
UNIT BOUNDARY
CHECK PLOT
NORMAL INFESTATION 0-25 TREES PER SECTION
NORMAL INFESTATION 25-50 TREES PER SECTION
LIGHT EPIDEMIC INFESTATION 50-100 TREES PER SECTION
MODERATE EPIDEMIC INFESTATION 100-200 TREES PER SECTION
HEAVY EPIDEMIC INFESTATION 200-400 TREES PER SECTION
CUT-OVER AREAS JAN. 1, 194
SCALE 1 INCH - 12 MILES
MITCHELL AREA
PRINEVILLE AREA
OCHOCO CREEK AREA
SUMMIT PRAIRIE AREA
MAURY MTN. AREA
SNOW MTN. AREA
TROUT CREEK
MCKAY CREEK
MILL CREEK
MARKS CREEK
BIG SUMMIT
BADGER
WATERMAN
ANTONE
MUD SPRING
WOLF CREEK
ANTLER
PAULINA
SUNFLOWER
NAURY
EMIGRANT
ALLISON
DOE SPRING
BALD MTN.
WHEELER
CROOK
DESCHUTES
JEFFERSON
GRANT
HARNEY
MALHEUR
BURNS

Fig. 1

Introduction.

Surveys of the forest-insect situation in the ponderosa pine stands on the Cañoco National Forest and private lands within and adjacent to the forest have been conducted annually since 1932. As in the past, this season's survey has been carried out cooperatively by the Forest Service and the Bureau of Entomology and Plant Quarantine. The Forest Service employed a crew of three Field Assistants to carry on the intensive field work, while the Bureau furnished the technical supervision of the crew and made an extensive reconnaissance of the forest.

Purpose of Survey.

The purpose of the survey is four-fold; (1) To determine the yearly trend, intensity, and distribution of the western pine beetle (Dendroctonus brevicomis Lec.); (2) to ascertain the need for artificial control work, and to study the results of such work as was undertaken; (3) to provide additional information on the life history of the western pine beetle as a basis from which it may become possible to predict future infestation trends; and (4) to provide the basis for rating individual trees and forest areas according to their relative risk of beetle attack as an aid to timber management.

Methods Used.

The survey was both extensive and intensive in character. The intensive work was carried on by the three-man crew, and consisted of making a 100 percent cruise of current beetle losses on the 320-acre check plots as well as a 10 percent volume and stand structure cruise of the green ponderosa pine stands. This cruise was made by the circular 1/4-acre random plot method, which was readily combined with the regular spotting practice and required but little additional time.

The writer carried out the extensive reconnaissance by using loss data obtained on the check plots as a guide. An ocular estimate of the 1938 infestation was made on a par-section basis for the forest. To make these estimates, observations were made from 25 primary or emergency lookouts as well as from many other points of vantage and roads on the forest.

Period of Survey.

The survey was carried out during the period August 6 to September 18.

Survey Personnel.

The members of the survey crew consisted of Under Field Assistants Charles Wilson and Jack Ostlind, and Junior Field Assistant Richard Goodall (Crew Leader), supervised by W. J. Buckhorn of this Bureau. Goodall and Ostlind previously had two seasons' experience; Wilson, with other inexperienced Under Field Assistants, was given eight days of intensive instruction at a training school held at Camp Sisters, Deschutes National Forest.

Intensive Acres Covered.

Twenty-eight plots containing 8,734 timbered acres, with a stand of 106,231,000 board feet of pine, were cruised for insect loss. Of these plots, 27 had been cruised last season and one was established this season. A 10 percent cruise of the green stand was made on 20 of the plots containing 6,400 acres. Two of last season's plots were lost due to cutting operations.

The location of check plots cruised in 1939 is shown on figure 1, which also shows the area and units, with boundaries. Ample descriptions of the areas are contained in last season's report and will not be recounted here.

To simplify reference to any certain plot without using the G.L.O. description each time, the plots will hereafter be referred to by name, which usually has been selected from some well-defined physical character on or near the plot, and generally is known to local forest officers. Table 1 gives these designations and other pertinent plot data.

Extensive Acres Covered.

The extensive estimates covered 1,366 sections, or 874,000 acres, having a stand of 8,432,000,000 board feet of ponderosa pine. Figure 2 is a map prepared from these estimates showing the intensity and distribution of the 1938 infestation.

Past Losses.

Aided by the cumulative effect of drought conditions which greatly lowered the resistance of the pine stands, an insignificant endemic infestation of the western pine beetle began to build up rapidly during 1930. In 1931 the infestation received added

impetus from the effects of a terrific windstorm occurring in April, which blew down a large amount of timber and left much of the stand in a badly shaken condition. Under such favorable conditions the epidemic mounted rapidly, reaching its greatest intensity in 1932, when 4.79 percent of the entire pine stand was killed. On two check plots on the Prineville Area losses during 1932 amounted to 17.56 and 11.06 percent of stand killed, respectively.

The upward trend of the infestation was broken by sub-zero temperatures which occurred during the winter of 1932-3, causing a 69.1 percent 1/ mortality to overwintering broods of the western pine beetle. Additional periods of sub-zero temperatures occurring in the fall of 1935 and winter of 1936-7, coupled with more favorable conditions for tree growth, caused further decline of the beetle populations. Extensive artificial control operations accelerated the decline in certain areas. Except in a few localized areas, the downward trend of infestation reached a low point in 1937.

Recent Losses.

The 1939 survey of check plots completed the information on the total 1938 losses and gave preliminary data on the trend of 1939 losses. A summary of these data is given in table 2. At the time of survey less than 60 percent of the total 1939 loss had developed, the probable total loss being estimated by employing a factor based on date of cruise. Although subject to considerable error, it does give an indication of the probable 1939 loss trend.

A comparison of loss trends on check plots for the three-year period 1937-9 is given in table 3. These data show the infestation trend continued downward through 1937 on all except the Maury Mountain and Prineville Areas, on which moderate increases occurred. During 1938 the infestation continued downward on the Mitchell Area and declined on the Prineville Area, but assumed or continued an upward trend on the Ochoco Creek, Summit Prairie, Maury Mountain, and Snow Mountain Areas, infestation developing aggressive tendencies on the Snow Mountain Area. The tentative 1939 plot data indicate a downward trend on all except the Ochoco Creek and Snow Mountain Areas. Indications are that the aggressive infestation on the Snow Mountain Area will continue the upward trend.

1/ "Low Temperatures as a Limiting Factor in Western Pine Beetle Epidemics, 1933" - F. P. Keen, Entomologist, and J. A. Beal, Assistant Entomologist.

Estimated Losses for 1938.

Estimated losses for the forest as a whole are given by units and areas in table 4 and summarized by areas in table 5. In general, these losses more or less follow the plot trends which form the basis for these estimates.

The infestation trend was downward from the 1937 level on the north portion of the forest. Centers of moderate epidemics present last season on the Mitchell and Prineville Areas are declining.

On the south portion of the forest a general increase of infestation occurred. Aggressive infestation was found to exist in the fringe-type stands of all areas on this side of the forest. Centers of moderate epidemics were found to have developed on the Sunflower Unit and assumed aggressive proportions on all of the Snow Mountain Area except a small portion southeast of Green Butte in the Bald Mountain Unit and at the higher elevation of Snow Mountain. Also, a small center of heavy epidemic was found to exist on this area just north of Dry Mountain.

Control Work.

An infestation of the western pine beetle on the east half of the Maury Mountain Area mounted steadily upward through 1936 and 1937, and a slight drop occurred during 1938, but group killings indicative of epidemic conditions were prevalent. Losses on two plots, Double Cabin and Run Rock, on this portion of the area were 136 and 219 board feet per acre during 1938, the latter figure being the second highest on the forest, exceeded only by the Soda Spring Plot of the Snow Mountain Area. During the three-year period 1936-8, losses on these plots amounted to 4 percent of the stand.

To reduce this infestation to a more normal level and to forestall the possibilities of a severe epidemic developing as a result of the serious deficiency of precipitation during the past season, it was thought desirable to clean up the infestation on that portion of the area lying east of Drakes Peak.

Spotting on the project began about the middle of October, covering a total of 5,600 acres. Due to hazardous fire conditions, treating did not get under way until several weeks later. Altogether, 263 trees on 3,240 acres were treated, an average of 52 trees per section.

Other Insect Damage.

During the 1939 season a very aggressive epidemic of the Oregon engraver beetle (Ips oregoni Eich.) developed on the Wolf Creek logging operations, and to a lesser extent on the other operations. Large groups of ponderosa pine reproduction and poles were killed. This damage is not so much a threat to the stocking of the stand, but will cause a 20- to 60-year reduction in age of much of the future stand, as the killing usually removes the entire centers of groups where the more thrifty dominant trees are found.

This outbreak probably is a result of favorable conditions existing when the logging operations created a disturbance, and large amounts of host materials which enabled large beetle populations to develop and spread to the green stands.

In the light of past Ips oregoni epidemics, the infestation will undoubtedly subside on the present sites during the coming season, but may continue in the more recent cuttings when there is a supply of fresh host materials.

Weather Conditions, 1938-1939.

Temperatures and precipitation were near normal during 1938. A slight increase of .4° in average temperature occurred during 1939, but precipitation averaged 3.40 inches below normal. It is probable that this deficiency may be reflected in an upward trend of infestation during 1940.

Summary.

The upward trend of the western pine beetle infestation reached its greatest intensity on the Ochoco National Forest in 1932. Weather conditions unfavorable to the development of this beetle brought about a decline, which reached a low point in 1937.

The infestation assumed an upward trend on the south portion of the forest during 1938. The most aggressive infestation found exists on the Sunflower Unit and Snow Mountain Area. The tentative 1939 plot data indicate a downward trend on all except the Ochoco Creek and Snow Mountain Areas.

Control was recommended and carried out on the east portion of the Maury Mountain Area during the fall of 1939.

An aggressive epidemic of Ips oregoni developed during 1939 on the logging areas, especially the Wolf Creek Unit.

Temperature and precipitation were near normal for 1938. Temperature was slightly above normal for 1939 and precipitation was 3.40 inches below normal.

The following tables summarize the data obtained by the survey on check plots and give the estimated losses for the forest as a whole.

Table 1.—Description of Check Plots on the Ochoco National Forest.

Area and Unit	Plot Name	Location T.	Location R.	Location ½ Sec.	Elevation	Type	Site	Timbered Acres	Pine volume as of Jan. 1, 1938	Board Feet per Acre
Mitchell										
Waterman	Waterman	10	23	35E	4300	20.5	4	300	4,033,295	13,444
Badger	Lewis Rock	12	22	31N	5100	20.5	3-	290	6,986,580	24,092
Antone	Spanish Peak	13	24	23S	4300	20.5	4+	310	4,469,445	14,417
Prineville										
Trout Creek	Sheep Rock	11	16	23S		20.5	4+	320	4,656,800	14,552
	Stevenson	11	18	36E	5500	20.5	4	320	5,757,631	17,792
McKay Creek	Allen Creek	12	16	23E	4600	20.5	4	320	3,955,300	12,360
	Ridge	12	16	31E	4700	20.5	4	320	3,490,835	10,909
	Dry Creek	13	17	29E	3900	20.5	4	320	2,804,300	8,763
Mill Creek	Wild Cat	13	18	5E	4200	20.5	4+	320	3,509,160	10,966
Ochoco Creek										
Marks Creek	Hamilton Creek	13	19	9E	3800	20.5	5+	320	4,831,570	15,099
	Ochoco Station	13	19	27N	4300	20.5	4	320	3,750,410	11,720
Wolf Creek	Sulphur Spring	14	19	33E	3900	20.5	4	320	3,321,100	10,378
	Horse Heaven Cr.	15	20	18S		20.5	4	320	3,432,200	10,726

Table 1.—Description of Check Plots on the Ochoco National Forest (continued)

Area and Unit	Plot Name	Location			Elevation	Type	Site	Timbered Acres	Pine Volume as of Jan. 1, 1938	Board Feet per Acre
		T.	R.	Sec.						
Summit Prairie										
Big Summit	Black Mtn.	14	22	9W/2	4600	20.5	4	320	3,846,045	12,019
Pauline	Pauline Bu.	14	23	32E/2	5400	20.5	4	320	2,664,765	8,327
Mud Spring	760 Spring	14	26	7S/2	5400	20.5	4	320	5,650,075	17,656
Antler	Horse Prairie	15	21	29E/2	4600	20.5	4	320	3,059,390	9,560
Sunflower	Sunflower	16	26	33W/2	5200	20.5	4	304	3,252,790	10,699
Maury Mt.										
Maury	Kloochman Cr.	18	19	7W/2		20.5	4	320	4,831,655	15,099
	Double Cabin Cr.	18	20	10W/2		20.5	4	320	3,227,330	10,085
	Rim Rock Cr.	17	21	32W/2		20.5	4	320	3,940,419	12,314
Snow Mt.										
Allison	Thorne Mill	19	26	8E/2	4500	20.5	4	315	5,567,970	17,676
	Soda Spring	20	25	4W/2	5000	20.5	4	285	2,727,735	9,571
	Bixby Spring	20	26	12S/2	5600	20.5	4	290	2,883,135	9,942
Emigrant Cr.	Bear Butte	19	27	34W/2	5800	20.5	4	300	3,180,520	10,602
Doe Springs	Nicoll Creek	21	25	17W/2	5500	20.5	4	320	3,304,085	10,325
Bald Butte	Green Butte	21	27	25E/2	5700	20.5	4	280	2,314,740	8,267
	Emigrant Butte	21	28	6E/2	5300	20.5	4	300	2,782,165	9,274
Totals for Forest	28 Plots							8734	108,231,445	12,392

Table 2.—Summary of Check Plot Data, Survey 1939.

Areas and Plots	1938 Loss				1939 Loss				
						Estimated			
	Total Trees	Volume Bd.ft.	Bd.ft. per Acre	% of Stand	Trees Marked	Total Trees	Volume Bd.ft.	Board Feet per Acre	Percent of Stand
Mitchell									
Waterman	42	19,850	66	.48	6	19	12,426	41	.31
Lewis Rock	39	24,085	83	.35	5	15	9,900	34	.14
Spanish Peak	64	48,080	155	1.08	14	47	36,143	116	.82
Area Total	145	92,015	102	.60	25	81	58,469	65	.38
Prineville									
Sheep Rock	19	20,960	63	.45	25	38	37,392	116	.80
Stevenson	59	41,580	130	.73	21	35	26,250	82	.46
Allen Creek	17	8,500	27	.21	12	20	16,360	51	.42
Ridge	39	29,610	92	.85	10	17	10,420	33	.30
Dry Creek	14	6,210	19	.22	13	22	15,708	49	.56
Wild Cat	30	19,660	61	.56	14	23	16,997	53	.49
Area Total	178	126,540	65	.51	95	155	123,127	64	.51
Ochoco Creek									
Hamilton Cr.	24	28,670	89	.59	25	45	35,775	112	.75
Ochoco Sta.	19	16,810	52	.45	11	19	17,043	53	.46
Sulphur Spr.	51	64,500	201	1.95	21	39	34,982	109	1.07
Horse Heaven	14	16,360	51	.48	24	44	41,360	129	1.21
Area Total	98	126,340	99	.82	81	147	129,161	101	.85

Table 2.—Summary of Check Plot Data, Survey of 1939 (continued)

Areas and Plots	1938 Loss: Total Trees	Volume Bd.ft.	Bd.ft. per Acre	% of Stand	1939 Loss: Trees Marked	Estimated: Total Trees	Volume Bd.ft.	Bd. Ft. Per Acre	Percent of Stand
Summit Prairie									
Black Mtn.	21	19,895	62	.57	9	22	18,350	57	.56
Paulina Butte	13	20,065	63	.75	8	23	16,560	52	.63
760 Spring	19	12,175	38	.22	3	8	7,560	24	.14
Horse Prairie	23	20,340	63	.67	6	16	14,656	46	.48
Sunflower	52	34,690	112	1.06	5	12	6,768	22	.21
Area Total	128	107,165	68	.58	31	81	63,894	40	.35
Maury Mtn.									
Klootchman	19	15,655	48	.32	13	27	20,304	63	.42
Double Cabin	73	43,630	136	1.35	27	56	34,384	107	1.08
Rim Rock	68	69,819	219	1.77	13	26	22,200	69	.57
Area Total	160	129,104	135	1.08	53	109	76,888	79	.64
Snow Mtn.									
Thorne Mill	21	23,970	76	.43	13	29	35,525	113	.64
Soda Spring	106	79,935	280	2.94	23	55	35,365	124	1.34
Bixby Spring	59	38,485	120	1.33	42	94	47,940	165	1.69
Bear Butte	65	59,120	197	1.88	57	133	114,912	383	3.68
Nicoll Cr.	62	42,335	134	1.30	31	77	122,130	380	3.74
Green Butte	58	35,290	126	1.52	33	72	48,960	75	2.15
Emigrant Butte	64	37,965	127	1.36	48	107	69,978	232	2.55
Area Total	435	317,600	152	1.40	247	677	474,810	230	2.10
Total for Forest	1145	898,764	103	.83	532	1240	926,394	106	.86

Table 3.--Infestation Trends on Check Plots for 3-Year Period 1937-1939.

Areas and Plots	1937 Bd.ft. per Acre	1937 Ratio 1937 to 1936	1938 Bd.ft. per Acre	1938 Ratio 1938 to 1937	1939 (Estimated) Bd.ft. per Acre	1939 Ratio 1939 to 1938
Mitchell						
Waterman	92	-	66	.72	41	.62
Lewis Rock	89	-	83	.93	34	.41
Spanish Pk.	209	-	155	.74	116	.75
Ave. for Area	130	-	101	.78	63	.62
Prineville						
Sheep Rock	-	-	63	-	116	1.84
Stevenson	113	1.53	130	.75	82	.63
Allen Cr.	70	2.50	27	.38	51	1.89
Ridge	111	1.14	92	.84	33	.36
Dry Cr.	82	1.52	19	.24	49	2.58
Wildcat	60	.97	61	1.00	53	.87
Ave. for Area	79	1.32	78	.67	77	1.00
Ochoco Creek						
Hamilton Cr.	81	.68	89	1.10	112	1.26
Ochoco Sta.	52	1.21	52	1.00	53	1.02
Sulphur Spring	155	.76	201	1.30	109	.54
Horse Heaven	65	.91	51	.77	129	2.33
Ave. for Area	88	.84	98	1.11	101	1.03
Summit Prairie						
Black Mtn.	24	-	62	2.58	57	.92
Paulina Butte	39	-	63	1.61	52	.82
760 Spring	102	-	38	.37	24	.63
Horse Prairie	60	-	63	1.05	46	.73
Sunflower	61	-	112	1.84	22	.20
Ave. for Area	57	-	67	1.18	40	.60
Maury Mtn.						
Kloochman	79	1.80	48	.61	63	1.31
Double Cabin	124	.80	136	1.10	107	.78
Rim Rock	208	2.19	219	1.05	69	.31
Ave. for Area	133	1.39	135	1.02	79	.78
Snow Mtn.						
Thorne Mill	-	-	76	-	113	1.49
Soda Spring	243	.96	280	1.15	124	.44
Bixby Spring	97	1.67	120	1.24	165	1.38
Bear Butte	161	-	197	1.22	383	1.95
Nicoll Creek	81	.73	134	1.65	380	2.84
Green Butte	66	.65	126	1.91	175	1.39
Emigrant Butte	114	.90	127	1.11	232	1.83
Ave. for Area	127	.90	152	1.29	224	1.47

Table 4.—Estimated Ponderosa Pine Losses for 1938, Ochoco National Forest.

Area and Units	Ponderosa Pine Acreage: Total	Ponderosa Pine Acreage: Virgin	Volume of Pine 1938, Mbm.	Estimated 1938 Loss: Trees	Estimated 1938 Loss: Volume Mbm.	Estimated 1938 Loss: Bd.ft. per Acre	Estimated 1938 Loss: % of Stand
Mitchell							
Waterman	42,000	40,680	326,000	4,600	3,000	71	.92
Mitchell	21,000	21,520	173,000	1,660	1,000	48	.58
Badger	26,000	24,280	357,000	2,290	1,900	73	.53
Antone	32,000	29,800	249,000	2,730	2,100	66	.84
Area Total	122,000	116,280	1,105,000	11,280	8,000	66	.72
Prineville							
Trout Creek	51,500	51,020	604,000	4,150	3,600	71	.60
McKay Creek	62,500	47,500	611,000	4,350	3,100	50	.51
Mill Creek	34,000	33,000	300,000	2,170	1,600	47	.53
Area Total	148,000	131,520	1,515,000	10,670	8,300	56	.55
Ochoco Creek							
Marks Creek	68,500	63,440	842,000	4,000	3,400	50	.40
Wolf Creek	68,500	66,540	729,000	6,600	5,100	75	.71
Area Total	137,000	129,980	1,571,000	10,600	8,500	65	.54
Summit Prairie							
Big Summit	70,000		775,000	2,280	1,900	27	.24
Antlers	41,500		466,000	3,170	2,900	70	.62
Paulina	37,500		340,000	2,780	2,000	58	.58
Mud Spring	18,500		174,000	1,590	1,500	100	.86
Sunflower	25,500		187,000	3,900	2,200	112	1.18
Area Total	193,000		1,942,000	13,720	10,500	54	.54

Table 4.—Estimated Ponderosa Pine Losses for 1938, Ochoco National Forest (continued)

Area and Units	Ponderosa Pine Acreage: Total	Ponderosa Pine Acreage: Virgin	Volume of Pine 1938, Mbm.	1938 Loss (Est.): Trees	1938 Loss (Est.): Volume Mbm.	1938 Loss (Est.): Bd. ft. per Acre	1938 Loss (Est.): % of Stand
Maury Mtn.							
Maury Mtn.	55,000	54,360	445,000	5,400	4,000	73	.90
Snow Mtn.							
Allison	65,000	65,000	534,000	9,300	7,400	114	1.25
Emigrant	63,000	63,000	471,000	6,500	5,600	89	1.19
Doe Springs	31,000	31,000	336,000	7,200	5,000	161	1.49
Bald Butte	60,000	57,760	453,000	10,700	7,000	117	1.55
Area Total	219,000	216,760	1,854,000	33,700	25,000	114	1.35

Table 5.—Summary by Areas of Estimated Ponderosa Pine Losses for Season 1938

Area	Ponderosa Pine Acreage		Volume of Pine 1938, Mbm.	Estimated losses			
	Total	Virgin		Trees	Volume Mbm.	Bd.ft. per Acre	% of Stand
Mitchell	122,000	116,280	1,105,000	11,300	8,000	66	.72
Prineville	148,000	131,520	1,515,000	10,700	8,300	56	.55
Ochoco Creek	137,000	129,980	1,571,000	10,600	8,500	65	.54
Summit Prairie	193,000	193,000	1,942,000	13,700	10,500	54	.54
Maury Mtn.	55,000	54,360	445,000	5,400	4,000	73	.90
Snow Mtn.	219,000	216,760	1,854,000	33,700	25,000	114	1.35
Forest Total	874,000	841,900	8,432,000	85,400	64,300	74	.76

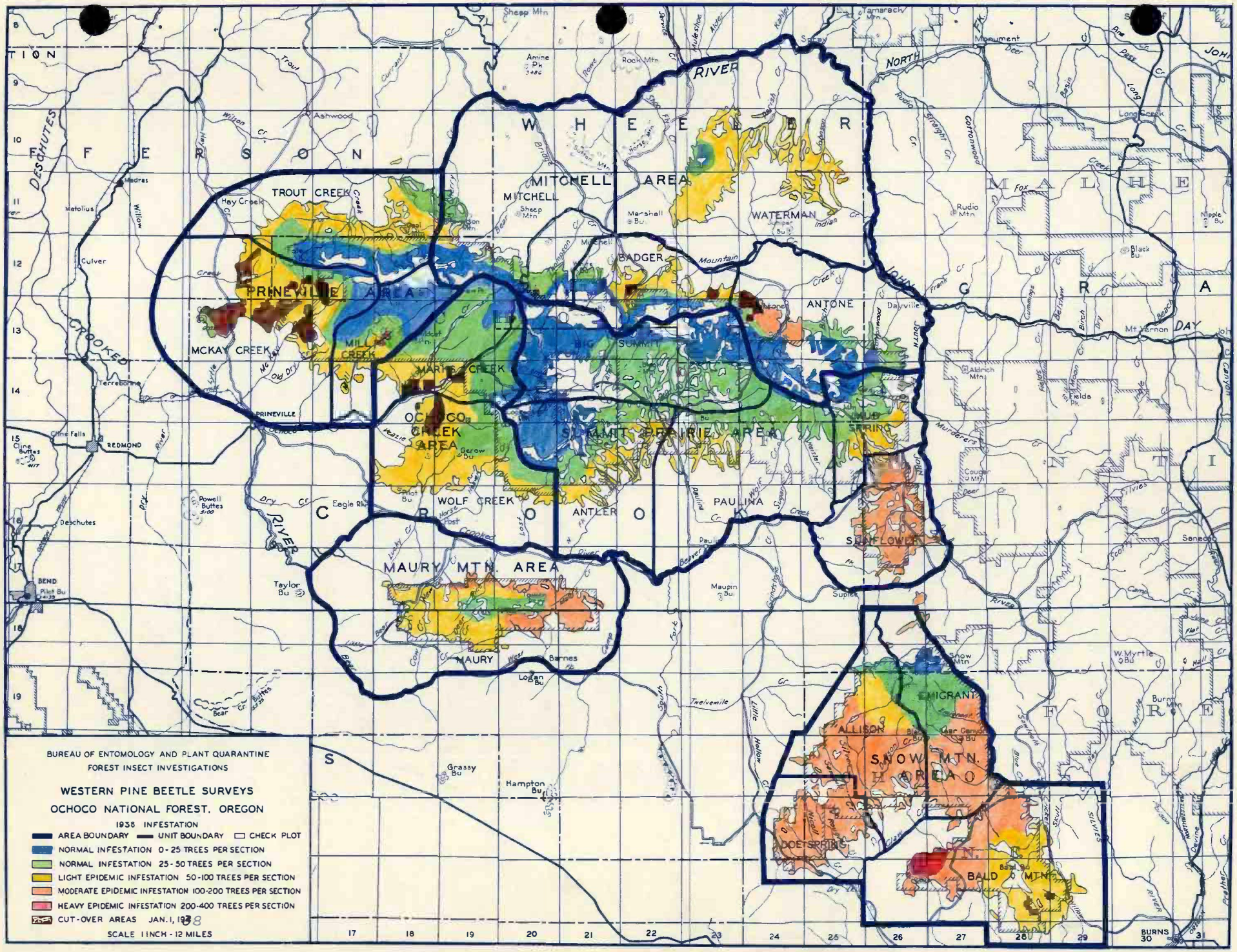
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
FOREST INSECT INVESTIGATIONS
WESTERN PINE BEETLE SURVEYS
OCHOCO NATIONAL FOREST, OREGON
1938 INFESTATION
AREA BOUNDARY
UNIT BOUNDARY
CHECK PLOT
NORMAL INFESTATION 0-25 TREES PER SECTION
NORMAL INFESTATION 25-50 TREES PER SECTION
LIGHT EPIDEMIC INFESTATION 50-100 TREES PER SECTION
MODERATE EPIDEMIC INFESTATION 100-200 TREES PER SECTION
HEAVY EPIDEMIC INFESTATION 200-400 TREES PER SECTION
CUT-OVER AREAS JAN. 1, 1938
SCALE 1 INCH - 12 MILES
TROUT CREEK AREA
MITCHELL AREA
PRINEVILLE AREA
OCHOCO CREEK AREA
SUMMIT PRAIRIE AREA
MAURY MTN. AREA
SNOW MTN. AREA
BALD MTN.
WHEELER
CROOKED
DESCHUTES
JOHN DAY
MALHEUR
FOREST
REDMOND
BEND
PRINEVILLE
MITCHELL
ANTONE
DAYVILLE
MT. VERNON
SUNFLOWER
MUD SPRING
PAULINA
ANTLER
WOLF CREEK
MCKAY CREEK
MILL CREEK
MARTIN CREEK
BADGER MOUNTAIN
WATERMAN
EMIGRANT
ALLISON
DOETSPRING
MAURY
BURNS

Fig 2